REVIEW OF RESEARCH PERTAINING TO DAIRY CATTLE MANAGEMENT

by

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INTRODUCTION

Farmers' incomes are greatly affected by the general price level and by the way they manage their farms. According to Tremblay (45), fluctuations in the general price level cause farm incomes to be higher in some periods than in others, but farmers have little or no control over these variations. However, wide variations exist in the incomes made by individual farmers in any given year because of differences in the way they manage their farms.

King et al. (36), considers the land and the kinds of crops it will grow as the basic starting point in the development and maintenance of a long time dairy program on the farm. The land must be kept productive and the soil conserved if the dairy enterprise is to be profitable.

The more efficient field equipment can be used most satisfactorily where the fields are of fair size and free of obstacles such as wet spots and rocks. With such equipment, manpower is more productive and larger areas can be operated with the available labor. Woodworth (53) feels that improved cultural practices such as liming, fertilizing, and more frequent reseedings result in larger yields as the carrying capacity of the farm increases, and the operator can keep more cows. He further states that with modern well arranged barns and new methods, the larger herd can be handled more efficiently. The advantages of each separate improvement are not fully utilized until all are integrated into a good economic unit.

King et al. (36) recommend that dairymen strive to produce high

quality hay, silage and pasture. With this in mind, the following factors need to be considered in developing the feeding program: (1) the quality and quantity of hay, silage and pasture; (2) the breed; (3) weight of the cow; (4) amounts of roughages the cow will consume; (5) daily milk production; and (6) the length of time since the cow has freshened (36).

Arnold et al. (1) encouraged dairymen to try and have cows freshen at regular intervals during the year, in order to meet the demand of their market for milk. Peak milk production generally occurs about six weeks later than calving.

The principal cost of milk production is feed. Large outlays are also made for labor, cows and equipment. As explained by Pritchard (39), gross returns from dairying are the products of milk prices and quantities sold. It is to be expected that a rise in milk prices relative to production costs usually will induce farmers to increase milk outputs. A relative decrease in milk prices ordinarily will have the opposite effects.

There is still the need for reducing distribution costs and retail prices to promote increased milk consumption (39).

LAND INVESTMENTS AND LAND USE

With farm land values now at or near an all time peak, the question of how much capital is required to own and operate a successful farm is of wide concern (Scofield, 42). In terms of national averages for 1950, about $3000 was invested in farm real estate for every $1000 taken in from the sale of farm products (Table 1).

Table 1. Real estate investment per $1000 gross income by economic class of farm, 1950 census (42)

REGION	INCOME CLASS OF FARM						ALL FARMS
	$25,000 and over	$10,000 to 24,999	$5,000 to 9,999	$2,500 to 4,999	$1,200 to 2,499	$ 250 to 1,199	
Northeast	1,064	1,638	2,051	2,891	5,130	10,007	1,979
Appalachian	1,490	2,341	2,668	2,813	3,551	6,046	2,900
Southeast	1,695	2,460	2,548	2,538	3,008	4,613	2,555
Lake States	1,300	2,300	2,660	3,145	4,243	7,391	2,743
Corn Belt	1,839	3,257	3,731	4,176	4,937	7,728	3,422
Delta States	2,351	2,573	2,757	2,452	2,510	4,163	2,690
Great Plains	1,810	3,124	3,836	4,653	5,970	10,337	3,495
Texas-Oklahoma	2,794	3,383	3,657	4,116	5,250	7,939	3,526
Mountain	2,032	3,159	3,805	4,752	7,069	13,782	3,053
Pacific	2,176	3,463	4,384	5,817	8,777	18,073	3,121
United States	1,988	2,920	3,323	3,675	4,340	6,512	3,066

Generally speaking, the lower the level of gross sales, the larger the investment in real estate per $1000 of product sold. Many of the low income farms in Scofield's study (42), (those of gross sales only $250 to $1200 a year) are near urban centers and the values on them do not reflect strictly agricultural values. In this income range it takes about $6500 in real estate to produce $1000 in sales. At the other extreme, for farms producing $25000 a year in gross sales, only $2000 in real estate was required to produce $1000 in gross income. On the high income farms it would take about two years for gross sales to equal the value of real estate, whereas in the low income farms it would take six and a half years (42).

Regional differences in the relationship between real estate investment and gross income reflect the relative contributions of land, labor, and the operating capital to the typical farm business of the area. Except in the South, real estate investments are usually higher in relation to gross income in areas where field crops are the predominant source of income than in livestock areas where labor inputs are larger and more invested in livestock (42).

As stated by Scofield (42), real estate investments increase as farm income increases, but not in direct proportion. He believes it takes less investment in real estate to produce $1000 in gross sales on farms with a high level of income than on low income farms. This has a direct effect on debt paying capacity and mortgage risk.

More investment in real estate is required to yield a given level of sales in the Mountain and Pacific Coast States than elsewhere.

Real estate per $1000 sales is lowest in the Northeast and Southwest (42).

Size of farm increases more rapidly than value per acre as farm income increases. The large investments in real estate associated with high levels of farm income are due to larger acreages instead of better land (42).

Ideal tillage conditions as enumerated by Carter (13), require a concurrence of fairly level land, good drainage, and freedom from stones. These conditions are particularly important when power machinery is used.

Slope is important in relation to agricultural operations not only because of its effect on ease of tillage, but also because of its relation to erosion. A ten percent slope is taken as the maximum for easy cultivation (13).

The proper care and use of barnyard manure, commercial fertilizers and lime, together with a good cropping system and the proper care of livestock, may so improve a poor soil that it will produce excellent crops. On the other hand, poor farming methods may so deplete a soil as to prevent it from producing crops as good as might have been expected in view of its potential capacity (13).

Farm units drop out at a much faster rate in areas where farm operations are difficult than in areas where conditions are favorable for farming. Use of marginal land is at an increasing disadvantage as agriculture becomes more mechanized and interregional competition for markets develops.

In the better land classes surveyed by Carter (13), there are fewer but larger farms, carrying more animal units per farm, and growing more crops per animal unit than formerly. If this trend continues as it has in the past, the social and economic forces will eventually bring about complete abandonment of land unsuited to agriculture.

DAIRY FARM ORGANIZATION AND MANAGEMENT

Profitable farming tends to be associated with certain factors which affect net income (Kuhlman et al., 37). The net income derived from farming usually varies directly with the size or volume of the business operated.

Size of business always has considerable effect on earnings (Houghaboom et al., 28). One good measure of size on dairy farms is the number of milking cows kept. Income generally increases with herd size (28, 29, 30, 31, 32, 33, 34).

Houghaboom et al. (28, 29, 30, 31, 32, 33, 34), thinks a better measure of size is the number of man-work units per farm. Man-work units are figured on the basis of the number of 10 hour work days required to do a given job. Under average conditions it takes 14 days of work to care for one cow for a year. Whether size of business is measured by the number of cows kept or by productive man-work units, a large farm is more profitable.

On small farms a considerable amount of time is spent in getting ready to do something and in finishing up the job. It does not take four times as long to care for 40 cows as it does for 10 cows. Equipment

costs do not increase with the size of the farm business. It takes nearly as much equipment to run a small farm as it does to run a large one (28, 29, 30, 31, 32, 33, 34).

Machinery and equipment required to operate a 60 cow dairy is only slightly greater than that required to operate a 35 cow dairy. Larger herds have less machinery and building maintenance cost per cow than smaller herds. The result is higher net profit per cow and more total net income (Kuhlman et al., 37).

Efficient production is often as important as high production in securing the highest net farm income, particularly if the extra pounds of butterfat are produced at a feed cost which is more than the extra butterfat is worth (37).

Low incomes are most often the result of small size, low production rates, inefficient use of labor or capital, or a combination of these factors (28, 29, 30, 31, 32, 33, 34). Houghaboom et al. (28, 29) believes capital efficiency may often mean the difference between profit and loss. Almost without exception, cost of production decreases as the amount of milk per cow increases (28, 29, 30, 31, 32, 33, 34).

No single formula will assure every farmer a good living (30). Each farm is different. Each farm operator has different desires and capabilities (28, 29, 30, 31, 32, 33, 34).

The dairyman has little control of the prices he receives and pays. But he does have control of the organization of his own farm and has an opportunity to increase net income by operation under a more efficient organization (38).

Most dairymen are unable to supply the relatively large amounts of capital needed to purchase stock and equip a commercial dairy farm from their own funds. Usually he can obtain the additional capital necessary for reorganizing only by borrowing (38).

The principal reason for obtaining a commercial loan is to build the dairy enterprise into a more economic unit by enlarging or improving it. Thus the dairyman is able to become a more productive operator. The ability to use credit wisely is of the utmost importance to the borrower, but there is no simple answer to what constitutes wise use of credit (38).

The individual operator who can take full advantage of modern methods are able to expand their output and secure efficient production. Most dairymen have a large task ahead in reorganizing their farms and in learning new skills and adapting improved practices (53).

Dairy farms may be reorganized in several ways; by buying additional cattle to increase the size of the herd, by raising good replacements to improve the herd, by adding or improving tillable fields to increase the productivity of the farmland, and by adding supplementary enterprises (38).

A typical farm reorganization plan, is suggested by Woodworth (53). The operator is interested in increasing the volume of milk produced, and he can build up the farm to carry 30 or more cows. By setting a moderate goal of 30 cows, the extra investments can be held at a low level. This will give the operator time to test out his management ability. Then in five or ten years he may be in better financial condition to undertake further expansion (53).

In Woodworth's plan (53), starting with 18 cows, the shift to 30 cows would require barn remodeling, development of greater roughage production and the addition of 12 cows through purchase of growing heifers. All these changes require time and an investment of capital.

It was suggested that the herd be expanded in two stages. First is the addition of six cows in the fall and then two cows a year beginning in about six months. Expansion to 24 cows rather quickly will give added income which will be needed to carry the cost of improvements. The available labor can milk and care for the extra cows. In adding the extra cows as soon as possible, a larger quantity of manure will be available to bring up the productivity of the farm more quickly (53).

In the long run, all necessary roughage should be produced on the farm. On a permanent basis, the cost of production is higher where roughages are purchased. However, when the dairyman wishes to expand rapidly, it is advisable to keep as many cows as convenient even if some hay must be purchased (53).

The condition of the barn has been the major handicap in working out a program for reorganizing the farm. In building a barn for production of fluid milk, the location of the milk house should have priority. It should be located so that travel at milking time is at a minimum as well as being accessible for the milk truck (53).

A person with cash at his disposal is in a good bargaining position in making purchases and may take advantage of favorable prices. Farmers indicated that a minimum of $200 in cash should be held by the individual farmer in order to maintain a satisfactory bargaining position.

Thirty-eight percent usually had less than $25 in cash (Peterson, 38).

If the farm operator wishes to maximize his earnings, he must utilize all his factors of production to their full capacity. Through the wise use of credit many good dairy farms could be developed to full capacity, thus creating opportunities for satisfactory family incomes. The good manager should develop a source of credit and use it productively (38).

The efficient operation of the farm will be advanced by developing high yields through improved practices on all tillage acreage (53). To carry out such a program it is suggested that the operator use the following six year rotation; corn for silage, oats for hay, legume hay, mixed hay, mixed hay, hay.

The application of fertilizer suggested as a part of land improvement to develop the farm to carry 30 cows will be expansive. Roughly it is estimated that it would cost over $500 per year for fertilizer. This is a large investment but it should be profitable as shown in increased yield of roughage and greater carrying capacity in number of cows (53).

If an operator on a good dairy farm is expecting to continue in production, he can afford to apply heavy applications of fertizers. A portion of the cost of fertilizing and of carrying out the cropping program will be returned quickly in the form of better quality roughage and lower grain feeding (53).

Carter (14) feels that dairymen do not always recognize the income producing power of the woodlot. Many of the products of the woodlot are

used on the farm as stove wood, fence posts, sugar wood and maple syrup. The commercial value of the forest is recognized only when a sizable amount of saw timber or cord wood is marketed.

The labor requirement of the woodlot, except during sugaring, is very flexible. At any time the woodlot provides a place where unemployed help may be put to the productive work of laying up a woodpile, cutting fence posts or otherwise shaping forest products into a more usable form (14).

The average woodlot on the farms studied had 96 acres, the acreage varied directly with the size of the farm. In most cases it made up about one-third of the land area. The farmers valuation on their woodlots averaged $1845 (14).

Farmers received average returns of $1066 from the woodlot. Use of equipment was $40, labor for farmer and family $204, operating profit was $413. The portion of total returns that stayed with the farmer was $742 or 70 percent. The total returns per hour of labor varied with the product, and ranged from $1.90 for saw logs to $1.03 for sugar wood (14).

From the standpoint of forest management and of the maintenance of orchards, grazing is so destructive of maple seedlings that grazed orchards are not perpetuating themselves (Hitchcock, 25).

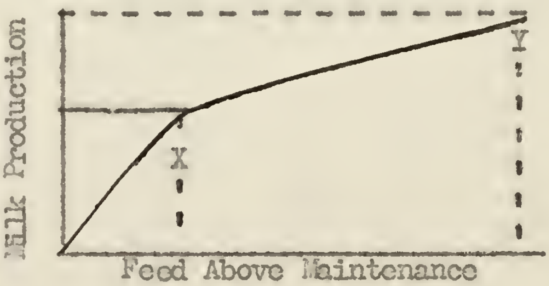
There is no precise agreement as to the most favorable month for freshening in terms of quality of milk produced (Bowring, 7). From the findings shown in Table 2, July and August freshening cows produce less milk per lactation period than cows freshening in other seasons. The

total milk production tends to be greater from cows freshening in the winter months.

Table 2. Month of Freshening Giving Highest and Lowest Annual Yields of Milk from Various Studies (7).

Study	Breed	Month highest annual yield	Month lowest annual yield	Low-high ratio
New Hampshire	Ayrshire	December	August	84
"	Guernsey	January	July	81
"	Holstein	December	June	84
"	Jersey	June	February	89
"	Milking Shorthorn	March	August	86
Connecticut	Ayrshire	January	July	86
"	Guernsey	February	July	88
"	Holstein	February	August	87
"	Jersey	January	July	84
12 States	All Breeds	November	July	97

A study on input-output relations for dairy cows by Bowring (7) indicated that feed above maintenance will produce additional milk but at a decreasing rate.



It will be profitable to increase feed for greater milk production while the marginal income from milk is greater than the marginal cost of the additional feed (7). At what point they will be equal on the production curve will depend on relative prices. It is conceivable that to increase milk production beyond point X despite the high proportion of milk relative to feed would be unprofitable. Likewise, to increase feeding for milk production at point Y may be profitable despite the decreasing rate of production per unit feed input. The highest profit combination in the short run will depend upon:

1. Productive capacity of herd, or productive response to increased feeding.

2. Price of milk.

3. Price of feed.

Given a competitive market, producers will attempt to maximize income by equalizing price and marginal costs (7).

The higher the price the more stable becomes the position of inefficient producers, and while there may be some slight increase in production, the cost to society is disproportionate. If prices were raised sufficiently to attract resources back into milk production, the higher price to consumers might result in a decreased demand and a search for substitutes (7).

LABOR USAGE

The task of milking largely determines the pattern for the size of the individual dairy enterprise. Operators have tended to keep as many

cows as they could milk conveniently (Woodworth et al., 56).

French (21) estimates that it takes 50 percent of the chore time in winter and 80 percent in the summer for milking. In Ohio and Wisconsin studies, 30-50 hours per cow per year were saved by using milking machines.

For efficient, quick, easy milking, a convenient pattern should consist of the following:

1. Milking is a special task and the operator must give full and uninterrupted attention to details during the milking period.

2. All hard milkers should be culled out.

3. Arrangement of the barn should be reasonably handy and the milk house conveniently located.

4. All equipment such as strainers should be adequate in capacity to take the large volume of milk when cows are milked fast.

5. The operator should make a trip to the milk house for each two cows (Woodworth et al., 56).

Most healthy normal cows can be milked by machine in three and one half minutes or less. In a few herds every cow milks out rapidly, but on the average dairy farm from 10 to 50 percent of the cows are slow milkers (Woodworth et al., 57).

In studies by Williams (49), no relation was found between the length of time the milking machine was left on cows and completeness of milking (Table 3).

Table 3. Relation of average machine time per cow to stripping time and weight of strippings, 79 farms (49).

Machine time per cow	Farms	Milking time per cow: Machine time	Milking time per cow: Stripping time	Strippings per cow: Farms	Strippings per cow: Amount
Minutes	No.	Minutes	Minutes	No.	Pounds
Less than 5.5	27	4.9	1.5	22	1.3
5.5 to 6.9	26	6.1	1.5	20	1.0
7.0 or more	26	8.5	1.9	24	1.2
Totals and Averages	79	6.5	1.6	6.6	1.2

These problem or slow milking cows are a definite handicap to efficient production. They require more labor per 100 pounds of milk and interfere with the sequence pattern in milking other cows (57).

In herds where good milking practices are followed, approximately 40 percent of the problem cows can be trained to milk out in reasonable time provided they have healthy udders. Problem cows should be stabled at the end of the milking line and given special treatment for a trial period of several months. If they do not respond they should be culled from the herd (57).

Fast milking characteristics are as important as many of the other desirable characteristics of a good dairy cow and the operator, over time, can well afford to give thoughtful consideration to milking quality when culling or in selecting animals for maintenance of his herd (57).

To maintain a milking rate of three minutes per cow it is often

necessary to use more than one man or machine (French, 21). A cart will make it easier to move pails and equipment along behind cows.

Loose housing should receive careful consideration when:

1. Remodeling or erecting new facilities.

2. Interested in maximum output per hour of labor.

3. Interested in keeping capital requirements per cow low.

Properly managed, loose housing can result in more manure, higher quality of milk, improved animal health and cheaper milk (21).

Major findings in work simplification studies on three types of housing facilities in Kentucky are shown in Table 4.

Table 4. Three major types of housing facilities (21).

Type of building	Building investment/cow 20 cow herd 1950 1/	Miles walked per cow annually.	Man hours labor per cow/year
Stanchion barn	$ 375	46	120
Stanchion barn and rest shed	475	43	147
Pit, tandem milking parlor and rest shed	275	28	85
Level, abreast milking parlor and rest shed 2/	225	26	75

1/ Includes silo, barn and milkhouse.
2/ New 20-cow pole type rest shed, silo, milkroom and 4-cow-abreast walk-through milking area.

As size of herd increases, investment per cow reduces with the walk

through milking parlor and rest shed. The same investment in milkroom and milking area is spread over a larger number of cows. Calculated investments per cow are: $185 for 30 cows and $100 for 60 cows (21).

The results of Ohio records on matched dairy farms of similar size are shown in Table 5. A well planned arrangement and efficient work methods are more important than the type of barn (21).

Table 5. Ohio records on matched dairy farms of similar sized herd (21).

Type	Hours per cow per year	Distance traveled /cow/day in ft.	Range in hours
Stanchion barns	97	742	70 to 110
Pen barns	92	615	44 to 148

Chore work in caring for cows was from 78 to 241 hours per cow. The men with low chore hour per cow had more convenient barns, used better methods, and organized the work more skillfully. However, the most efficient in some one practice are often inefficient in some other respect (Woodworth et al., 55).

In addition to stripping, the data regarding the time spent and the distance traveled per cow on the several jobs connected with the milking are summarized in Table 6. Observations indicate that convenience of arrangement, adequacy of equipment, and the extent to which the work has been planned to avoid waste motion are the more obvious factors determining the efficiency with which chore work is done (10, 49).

Table 6. Time spent and distance walked per cow on various milking jobs (49).

Job	Time per cow			Distance per cow	
	Farms No.	Range Minutes	Average Minutes	Range Ft.	Average Ft.
		Machine-milked herds			
Operating milker	14	0.9-2.0	1.2	14-69	37
Stripping and hand milking	14	0.9-3.6	2.1	9-24	14
Care of milk	14	0.2-0.9	0.5	14-77	47
Care of utensils	14	0.3-1.3	0.7	12-63	33
Totals	14	3.0-8.1	5.0	78-209	138
		Hand-milked herds			
Milking	11	4.4-10.0	7.2	8-48	18
Care of milk	11	0.3- 1.2	0.8	19-162	74
Care of utensils	10*	0.1- 1.3	0.5	2-30	12
Totals	10*	5.0-11.6	8.5	49-201	109

* Data on care of utensils not obtained on one farm.

The benefits from greater efficiency in chore work are more leisure, larger output per man or less hired labor (55).

On individual farms the output per man varies greatly (55). The difference is due largely to the more constant use of available labor on productive enterprises, better management of labor, more adequate equipment, higher quality cows, more skill in arranging a cropping system and

in more adequate pasture program (55).

Labor efficiency is important in reducing costs (Tremblay, 44). A good measure of the amount of work done is the tons of 4.0 per cent milk produced per man. As the quantity of milk produced per man increases, cost per hundredweight decreases. The farmers who fail to achieve less than average costs frequently have no return for their labor or for their service as farm managers.

When capital is substituted for labor it is expected that the advantage will be reflected in lower average costs. As the capital investment per man increases, cost per hundredweight of milk decreases (Table 7). In the group of farms with the high capital investment per man much productive work is done and a large quantity of milk is produced per man. This is possible by keeping large numbers of high producing cows per man (44).

Production is a prime factor affecting costs. Almost without exception, as the milk production per cow increases the cost of production decreases (Table 8) (44).

Table 8. Relation of milk produced per cow to costs (44).

Cwt. of 4.0 milk produced Range	Percent per cow Average	Percent of farms	Cost per Cwt. of milk
31 - 42	37	12	$ 6.44
43 - 50	47	26	5.08
51 - 58	54	26	4.39
59 - 66	62	14	4.64
67 - 74	71	11	4.27

Table 7. Relation of capital investment per man and labor efficiency to costs (44).

Capital investment/man Range	Average	Productive man work-units/man	Tons-milk produced per man	Percent of farms	Cost per cwt. of milk
\$ 2,087-\$ 6,000	\$ 4,674	199	21	17	\$ 5.55
6,001- 8,500	7,077	223	26	26	4.96
8,501- 11,000	9,696	272	37	25	4.60
11,001- 13,500	12,156	311	42	16	4.44
13,501- 16,000	14,790	380	49	8	4.40
16,001- 38,017	20,461	386	56	8	4.21
All farms	9,867	271	34	100	4.78

Table 8. Relation of milk produced per cow to costs (44). (Continued)

Cwt. of 4.0 milk produced Range	Percent per cow Average	Percent of farms	Cost per Cwt. of milk
75 - 132	86	11	$ 3.78
All farms	57	100	4.78

ROUGHAGE PROGRAM

To maintain dairying on a profitable basis, cost of production must be as low as possible (King et al., 36). Many items such as labor, overhead, disease and feed enter into cost. Of these the dairyman is able to do more about feed than any of the others.

According to Hitchcock and Williams (23) pasture, properly managed, is the best feed for dairy cows and is one of the most important factors in economical milk production. Even though the economic strength of dairying lies in grass, it requires careful planning and management to get the most from it.

Roughage such as pasture, silage and hay, is a cheaper source of nutrients than grain (King et al., 36). The dairy cow is a great roughage consumer. Many workers agree that a cow in full milk production can and will consume up to 75 percent or more of her required nutrients in the form of roughages. To get the best results, roughage must be palatable, of high quality and nutritious.

The more high quality roughage consumed by the cow, the less expensive grain she needs. Conversely, the poorer the roughage the less she

eats, and the more grain and protein supplement must be fed to make up the nutrient deficit. Better nutrition means longer productive life (36).

Pasture has some deficiencies (Hitchcock and Williams, 23). Among these are the fact that the grazing season is rather short and a cow may be on pasture for only one-third to one-half of her lactation period. Most of the growth occurs early in the season with the result of more feed than necessary at first and possibly not enough later in the season. The climate and soil type influence the growth of pasture plants and the quality of the grass changes greatly with the stage of maturity.

The kind of pasture provided greatly influences milk production. Work at Purdue with legume-grass pastures compared with grass pastures showed more produced per acre on the pastures containing legumes. The superiority of the legume-grass pasture was apparently due to the additional forage consumed throughout the season by cows grazing these pastures (23).

The notion has prevailed that cows could not produce more than thirty-five pounds of milk with pasture as the only source of feed, without loss in body weight. However, it is a common experience for dairymen to find that their cows will refuse concentrates when on luxuriant pastures. Good evidence supports the fact that the amount and quality of the grass are the factors limiting the performance of individual cows. Sufficient pasture should be provided for a cow to consume about 4.5 pounds of grass for each pound of milk produced. The number of cows per acre becomes one of judgment and experience in pasture management (Table 9) (23).

Table 9. The milk production of cows on pasture without concentrates (23).

Cow	Year	Type of pasture	Days on pasture	Milk produced on pasture	% of Total produced on pasture	Total production
10-P	1949	Poor	133	3,100	28.5	12,547
10-P	1950	Good	133	6,553	50.1	13,103
10-P	1951	Good	84	4,610	28.9	15,949
12-P	1949	Good	133	5,876	50.5	11,635
12-P	1950	Good	133	6,148	46.8	13,121
82-B	1949	Good	133	4,762	51.0	9,337
82-B	1950	Poor	133	3,942	46.1	8,541
56-B*	1951	Good	114	4,350	50.3	8,634
96-B*	1951	Good	114	4,189	50.1	8,359

* These cows managed so that roughage was the only feed throughout their lactation.

When pastures decline in productivity, as they frequently do on many farms during July and August, some supplementary roughage feeding is often advisable (Wilbur et al., 47). This is likely to be either hay or silage. In feeding trials silage made from alfalfa bromegrass was very similar in feeding value to corn silage for milk production (Table 10).

Usually silage made from legume or legume-grass mixtures will be higher in protein and carotene than corn silage but lower in TDN. However, when silage is fed over a long period, as in winter, some sun cured hay or vitamin D concentrate should be fed to insure an adequate supply

Table 10. Summary of the feeding trials comparing alfalfa-brome silage with corn silage for milking cows (49). (Length of trials - 10 weeks)

	Trial I		Trial II		Average of two trials	
	Corn Silage	Alfalfa-brome Silage	Corn Silage	Alfalfa-brome Silage	Corn Silage	Alfalfa-brome Silage
Number of cows	5	5	6	6	11	11
Total pounds of milk	9980.6	10855.2	10385.8	10131.3	20366.4	20986.5
Av. daily milk	28.5	31.0	24.7	24.1	24.1	27.2
Total pounds of fat	413.5	413.3	445.6	458.6	859.1	871.9
Av. daily fat	1.18	1.18	1.06	1.09	1.12	1.13
Total pounds at 4% F.C.M.	10217.6	10570.8	10828.1	10933.5	21504.7	21504.3
Av. daily 4% F.C.M.	29.2	30.2	25.8	26.0	27.3	27.9
Total pounds of grain consumed	3950.0	3965.0	3510.7	3668.0	7460.7	7633.0
Av. daily grain consumed	11.3	11.3	8.4	8.7	9.7	9.9
Total pounds of hay consumed	3323.8	3284.0	4176.0	4036.7	7499.8	7370.7
Av. daily hay consumed	9.5	9.4	9.9	9.7	9.7	9.6
Total pounds of silage consumed	10102.0	9584.0	12797.0	12405.0	22899.0	21989.0
Av. daily silage consumed	28.9	27.0	30.5	29.5	29.7	28.6
Av. initial body weight (pounds)	1100	1088	1037	1007	1068	1047
Av. final body weight (pounds)	1111	1083	1098	1042	1104	1062
Av. gain in body weight (pounds)	+11	-5	+61	+35	+36	+15

of vitamin D for the cows (47).

Table 11 compares alfalfa silage with medium quality first cutting alfalfa hay as a supplement to bluegrass pasture during July and August (47).

Table 11. A comparison of alfalfa silage with alfalfa hay as a supplement for bluegrass pasture (47).

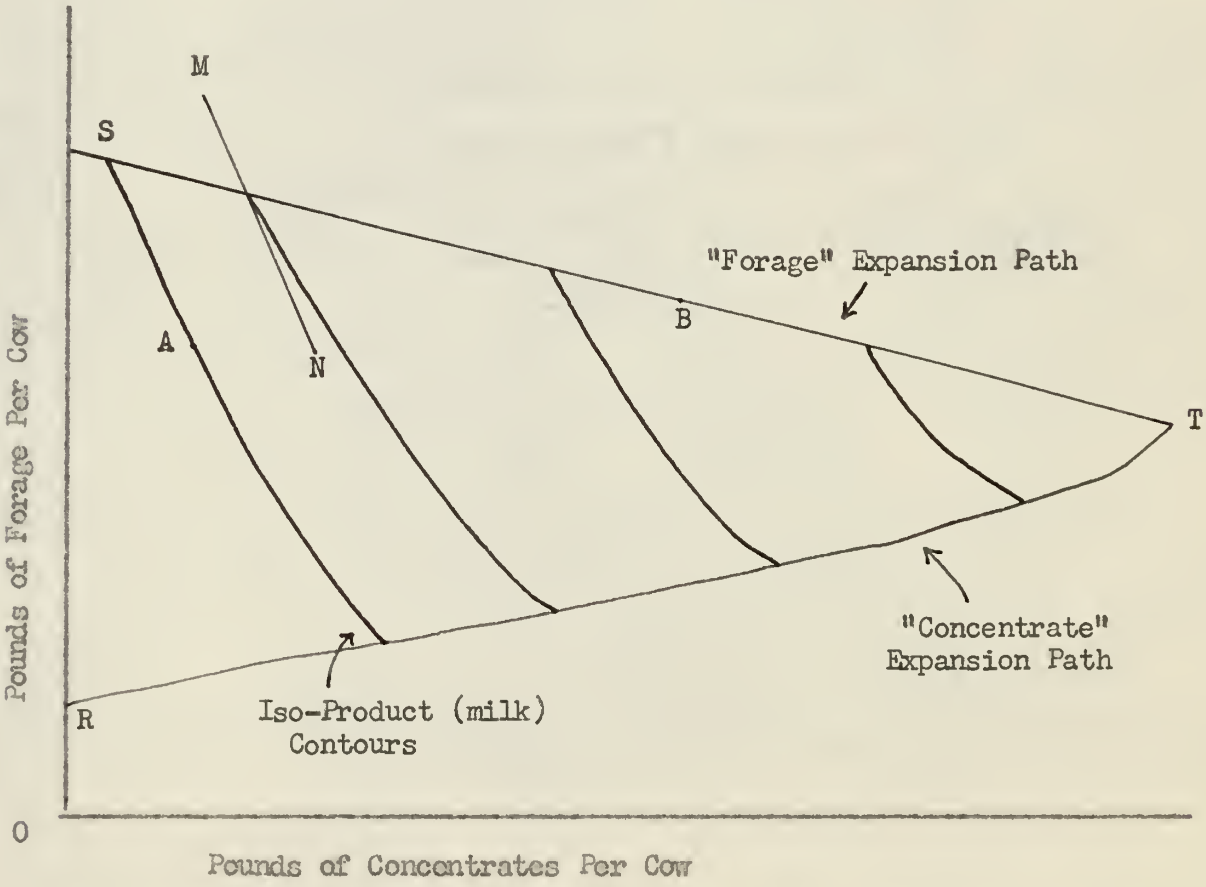
	Alfalfa-silage	Alfalfa Hay
Number of cows	7	7
Total pounds of milk produced	8872	9065
Av. daily milk produced	25.3	25.9
Total pounds of silage consumed	11291	——
Av. daily consumption	32.0	
Total pounds of hay consumed	——	6962
Av. daily consumption		19.8
Total pounds of grain consumed	2780	2700
Av. daily consumption	7.0	7.7

Basic economic considerations in grassland farming remain the same for all areas of the country. The regional emphasis underlines the fact that segments of the problem must receive different emphasis in different areas (Fellows, 20).

Fellows (20) considers the Northeast a feed deficient area. In general, no large shipments of roughage occur, but about 50 percent of

the feed concentrates for livestock are obtained from outside the region.

Dairying dominates the livestock industry in most of the Northeast (Fellows, 20). The development of the dairy industry has been due in part to the general adaptation of the area to the production of grasses and legumes. Production of high quality forage calls for crop selection, cultivation, addition of soil amendments, and special cultural practices (Fig. 1).



Because of physiological characteristics of the dairy animal RST is the relevant area of the production surface showing the structural

relationships between milk, forage and concentrates. Line ST is the upper limit on forage intake and is functionally related to milk output and concentrate intake. Line RT is the upper limit of concentrate intake given a minimum forage intake for output (20).

One possible expansion path enumerated by Fellows (20), is along the upper limit of forage intake. If the factors were close substitutes in the relevant area, the contours would have only slight curvatures. Price ratios rotating about points on intersection of contours at the upper forage limit could change considerably before the optimum combination would move along the contour. With the imperfection in milk marketing in the Northeast, the use of land for forage production has a considerable advantage over alternative opportunities.

Along the forage expansion path the marginal rates of substitution have been estimated by Fellows (20) as 1 to 3.7 at the 7000 pound contour, 1 to 2.4 at the 8000 pound contour and 1 to 2 at the 9000 pound contour. For these particular situations, the ratio is given to which the farm operator can adjust the price ratio of the two inputs.

Each farm operator is now able to determine the extent of forage production activities on his farm as long as the forage can be consumed. The operator must be able to use the additional roughage. This would be possible when the cow could consume more roughage and move to a higher production contour. When the cow can not consume more roughage, additional cows would need to be added. The profitability of movement along the forage expansion path could be tested only by budgeting each situation (20).

Fellow's (20) model can not solve all the problems of grassland economics. Management practices can be compared and forage production and use can be considered as an integrated problem. Of greatest importance, it diverts the thinking away from the objectives of wide milk grain ratios and of maximum grass acreages toward the goal of change in net farm income.

FORAGE HARVESTING

Harvesting the hay crop is hard, tedious, expensive work (Carter, 12). It is difficult to get haying help. The weather is either too hot or too wet (9). The working days are too long. Many of the jobs are back breaking. For these reasons, many farmers are searching for better methods of performing the essential haying jobs (9, 12).

While it is recognized that it may sometimes be economical to cut hay under unfavorable weather conditions there is no justification for doing so when this practice is avoidable. Many farmers fail to cut hay at the time of day when it can best be handled, even though no conflict of job exists (9).

The loss in quality and feeding value of hay is influenced by the amount of rainfall the hay receives (Ross and Fellows, 41). Unfavorable weather, by postponing the cutting date, may reduce the quality and quantity of the hay.

The economies incidental to large sized operations are not always appreciated. For both the cutting and raking jobs, less travel and turning time per acre are needed in large than in small fields (Table 12).

Table 12. Average time cost of cutting one acre of hay by various methods (9).

Job-method	Av. time cost Min.	Farms visited No.	Acres measured No.	Model crew size No.
Tractor & 7 ft. cutter bar	27	23	132	1
Horses & 6 ft. cutter bar	40	7	36	1
Tractor & 6 ft. cutter bar	53	4	10	1
Horses & 5 ft. cutter bar	56	15	33	1
Tractor & 5 ft. horse-type mower	139	2	6	2
Total cutting observations	—	51	217	-

Nearly all farmers rake their hay into windrows. Turning time and repair time was relatively unimportant in the raking job (Table 13).

Table 13. Average time cost of raking one acre of hay by various methods (9).

Job-method	Av. time cost Min.	Farms visited No.	Acres measured No.	Model crew size No.
Tractor & side-delivery rake	20	17	99	1
Horses & side-delivery rake	29	21	97	1
Horses & dump rake	30	7	18	1
Total raking observations	—	45	214	-

Hay may be tumbled into any suitable bunch size (9). Farmers spent less than one-third as much time per ton to bunch hay with the one man as with the three man baler (Table 14).

Table 14. Average time cost of bunching one ton of hay by various methods (9).

Job-method	Av. time cost Min.	Farms visited No.	Tons weighed No.	Model crew size No.	Limitations
One-man baler	23	7	101	1	Baled hay
Hand fork	66	6	18	1	Hand loading
Three-man baler	80	7	107	3	Baled hay
Total bunching observations	—	20	226	-	

In studies by Carter (9), baled hay was loaded very rapidly at the rate of 16 minutes per ton. The buck rake loaded loose in 32 minutes per ton. Loose hay loaded by a hay loader from windrows took 42 minutes per ton. The operator of the field chopper loaded a ton of chopped hay in 37 minutes.

Carter also stated that the time cost of each hay harvesting job is related to the equipment used. He believes a greater relationship exists between the time cost of each job and the way in which available equipment is handled and the labor force distributed.

The decision of the individual farmer to purchase a new hay tool should depend upon the savings which can be expected through its operation.

A saving of 20 hours a year might not justify additional investment, whereas a saving of 200 hours per year might be sufficient to warrant a change (9).

Ross and Fellows (40) reported that dairymen had been growing more legume grass mixtures in an effort to develop a forage program that will provide both hay and pasture. They also commented that this increased the risk in making field cured hay because legume and legume-grass mixtures produce a heavier growth than grass. The first cutting comes earlier in the season when weather is less favorable, and the forage has a high moisture content.

Ensiling, mow curing and field curing facilities represent an opportunity for a very flexible program (Holmes, 26).

The method most appropriate for individual dairymen will depend upon present farm organization, size of business and type of harvesting equipment (11).

Two types of adjustments may be made to minimize the effects of weather in forage harvesting, grass silage or barn finishing the hay (40).

MOW FINISHERS

In the last few years a number of dairymen have installed special mow drying equipment. The mow hay dryer may represent either a part or all of the hay storage (Holmes, 26).

Mow finishing is a technique or process wherein hay, partially dried in the field, usually to below 45 percent moisture, is put into specially constructed hay mows for further drying. This mow is equipped with a

system of air ducts spread over the mow floor. Air is driven through ducts by a motor driven fan and allowed to filter through the hay. Being somewhat drier than the hay, the air absorbs some of the moisture and eventually the moisture content is reduced to the desired 20 to 25 percent (Carter, 11).

Any handling of very wet hay greatly increases labor and lessens the chance of good curing. On the basis of these studies, savings in hay stored per acre would offset about one-third of the total cost per ton for mow finishing, assuming that half of the mow finished hay would have suffered tonnage loss if left out until field dried (11).

Carter (11) stressed the point that a mow finisher should not be purchased and installed simply because it is new and great claims have been made for its performance. All other alternatives should be checked before deciding whether or not some other capital investment would be more profitable.

The cost of substitution of barn finishing for field curing using present equipment is presented in Table 15. The effect on net income from shifting from field curing to the making of grass silage are not greatly different than for barn finishing (Table 16). Less labor is required in barn finishing the forage when presently owned equipment is used, and barn finishing would probably be preferred on this basis (Ross and Fellows, 40).

The cost of electricity per ton of mow cured hay depends on the condition and quality of the hay at the start. Holmes (26) estimates a range of 50¢ to $1.50 per ton is fairly representative of the cost of

Table 15. Estimated changes in annual cost and returns on dairy farms of specified herd size from the substitution of barn-finishing for field during, using presently owned equipment (40).

Item	Annual Cost and Returns Size of herd 15-cow	 25-cow	 40-cow
Increased cost		Dollars	
Annual fixed cash cost on installation			
Depreciation	40.51	48.78	55.32
Interest	20.25	24.39	27.66
Repairs	10.13	12.19	13.83
Insurance	3.80	4.57	5.19
Taxes	5.06	5.06	6.91
Operational cost			
Electricity	82.88	133.28	219.52
Total	162.63	229.31	328.43
Increased return			
Increased milk receipts	565.92	943.20	1,509.12
Changes in annual net cash income	403.29	713.89	1,180.69

electric current.

The availability of mow drying and ensilage facilities make it possible to harvest over a third of the first crop before the first of July. This third of the crop represents hay most difficult to cure and store at

Table 16. Estimated changes in annual cost and returns on dairy farms of specified herd size with the substitution of grass silage for field-curing using the stationary chopper and the green crop loader (40).

Item	Annual Cost and Returns Size of herd 15-cow	25-cow	40-cow
	Reduced Cost		
Reduced fixed cash cost			
Hay fork and accessories	8.28	8.28	.00
Side-delivery rake	33.54	33.54	33.54
Pick-up baler	.00	.00	356.08
Bale elevator	.00	.00	40.20
Reduced operational cost			
Equipment	.00	.00	178.36
Increased returns			
Increased milk receipts	778.14	1,296.90	2,075.00
Total	819.96	1,338.72	2,683.22
	Increased cost		
Increased fixed cash cost			
Truck	.00	.00	339.50
Loader	.00	.00	32.47
Windrower attachment	1.50	1.50	1.50
Silos	354.00	412.00	648.00
Increased operational cost			
Labor	72.54	116.66	308.00
Equipment	0.86	7.34	.00
Total	428.90	537.50	1,329.47
Change in annual net cash income	391.06	801.22	1,353.75

the time weather for field curing is usually unfavorable. On several occasions the hay drying equipment enabled the operator to haul in partially cured hay that otherwise would have been rained on (26).

This early harvest has two advantages:

1. The available labor and equipment are used to better advantage, being spread over a longer period.

2. The second crop has a better chance to develop making yields higher (26).

FORAGE HARVESTING EQUIPMENT

Several harvesting methods and combinations of equipment were being used (Carter, 12). The method is more important than the man using it. Labor is not always saved when new machinery is bought. Machinery which increases mechanical pride without increasing efficiency is a poor investment.

Fellows (18) believes the equipment combination should have adequate capacity to harvest the forage produced at various periods without excessive loss of quality from over maturing of some of the crops. Excessive capacity in equipment is expensive and unnecessary. Performance rates and cost data will help to strike a balance between over capacity and under capacity.

Fellows (18) commented that the forage harvesting equipment combination should be tailored to the size of the enterprise to avoid excessive overhead expenses. This is especially important when only a small annual tonnage is harvested.

The opportunity to have harvesting work done on a custom basis, or to increase the volume of work done by equipment by doing custom work for other operators, should be studied before a decision is made on a particular equipment combination (18). Figure 2, demonstrates the importance of volume in reducing overhead cost per unit and shows a method of comparing the cost of owning equipment against the cost of having it done by a custom operator (18).

On most farms the investment in equipment has increased rapidly in total value in relation to investment in other farm resources. On the average dairy farm the investment in equipment as a part of the total investment has increased nearly three-fold in the last 20 years (Fellows, 17).

The problem as seen by Fellows (17), is one of choosing equipment that will lead to a more efficient and profitable business. The balancing of costs and returns will indicate if the particular equipment or combination of equipment is profitable. Each operator should test the balance of additional costs and returns before purchasing equipment.

Two types of costs are involved when equipment is bought. The first type or fixed cost results simply because the farmer owns the equipment. Studies of equipment costs indicate that the fixed costs per year will be from 10 to 15 percent of the original cost. For most farm equipment 12 percent is a useful estimate of fixed costs (17).

Usually the largest item of fixed cost is depreciation. An estimated annual depreciation cost will range from 4 to 25 percent of the original cost, the average being about 7 percent (17).

The annual charge for the use of the money invested, interest, on

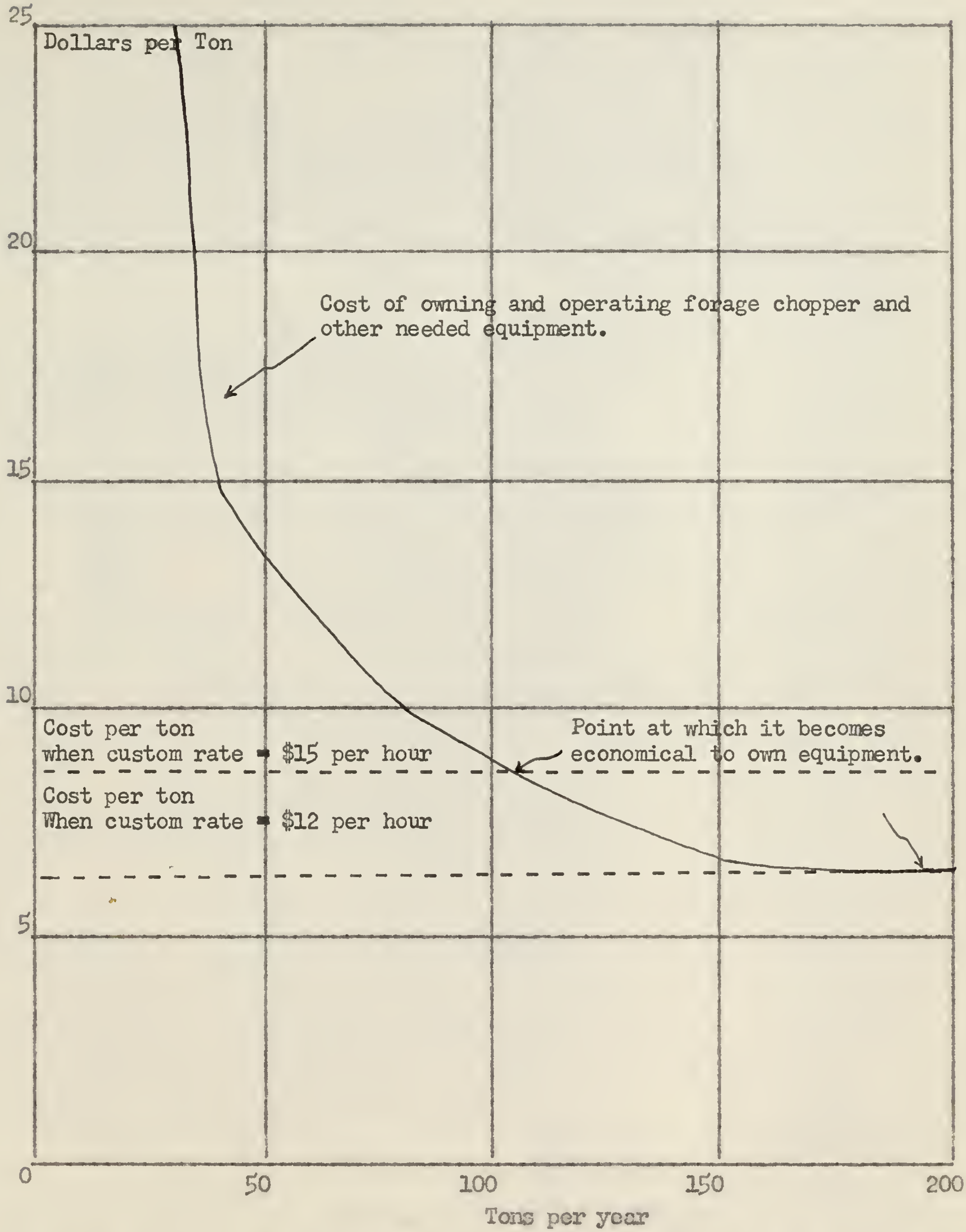


Figure 2. Comparison of costs for harvesting with a forage harvester on a custom basis and owned basis. (18)

each machine is 4 percent on half the original cost. Cost of repairs to keep the equipment in running condition will average 2 percent. The average annual cost of taxes, insurance and storage is about 1-1/2 percent of the original cost (17).

Variable costs are related to the use of the machine. The annual cost for operation will depend upon the amount of use of the equipment and cost of material. Variable costs for a medium-sized wheel tractor are about 45 cents per hour, electric current for horse power motor will cost about one cent per hour (17).

The fixed and variable costs make up the total costs associated with each piece of equipment (17).

Sometimes when equipment is added to the farm business, direct cash income is realized. Fellows (17) thinks such equipment increases the quantity or quality of some products which means greater total cash returns.

Fellows (17) stated that most returns for equipment are generally realized indirectly. He believes equipment may replace labor on the farm and save the labor expense. Replacing an old machine with a more efficient one may reduce costs. But usually the most important effect of equipment is to permit a larger size of business with the same amount of other resources. He stated that fixed costs of the total business can then be spread over a greater number of producing units. In this way more of the production from each cow in the herd can go for profit instead of overhead expenses.

Fellows (17) places importance on the non-cash returns associated with equipment. It is difficult to estimate the value of these returns,

but everyone realizes there are benefits from equipment that takes the hard work out of a job or eliminates unpleasant tasks. Each operator makes his own evaluation for this type of return.

Several problems should be considered, however, before the final decision is made. One problem arises because of the need of estimating future price. With the purchase of equipment, costs are committed with considerable certainty for several future years. If costs are offset only when expected prices are high, there may be considerable doubt about the desirability of adding the equipment (17).

Another problem enumerated by Fellows (17), concerns the integration of new equipment into the farm business. When a new machine is added he explained that adjustments may be required in buildings, labor, other equipment as well as feeding and work methods in order to get the full benefit of the machine. Unless these changes are made to fit the equipment into the organization, returns may be small.

Each operator should compare all the practical alternatives which are open to him. The opportunity of hiring equipment through custom operation rather than owning it should be considered. Most operators have some limit on the amount of capital available to them. The capital needed to buy the equipment might return more net income to the farmer if it were invested in some other way. After studying several practical alternatives the farm operator can choose the most profitable one. Then he will be working toward the most efficient and profitable use of all the resources on his farm (17).

Rates of performance for various combinations of hay harvesting

equipment are given in Table 17. Average annual harvesting cost per ton for various combinations of hay harvesting equipment is given in Table 18.

MILK PRODUCTION COSTS

Blackstone (4) considers it always advantageous for dairy farmers to analyze and know their production costs. Cost statements indicate where savings can be made and the extent to which the dairy may be expanded or contracted to increase profit. He explained that by studying the various factors that make up production costs a dairyman can tell the efficiency or inefficiency in organization and management of his farm. Some farmers produce milk at a low cost per hundredweight, while neighbors produce at an excessively high cost.

Individually, the farmer can do little about the general price level of milk. He can, however, increase his farming efficiency, and lower his cost of production. Since profits represent the difference between selling price and the cost of production, farmers should make intensive efforts to reduce production costs per unit of product whenever possible (4).

Reductions in production costs of a hundredweight of milk can best be achieved by the following:

1. Produce more and better roughage, pasture and feed grains. Much of this feed could be grown on the farm.

2. Improve feeding practices built around high quality roughages. In the case of many cows, no concentrates will be required if sufficient good pasture, temporary grazing crops and roughage is available.

Table 17. Average performance rates for various combinations of hay harvesting equipment and crews, when distance from barn to field is one-half mile (18).

Outfit Number	Major equipment used: Loading	Major equipment used: Unloading	Man equiv. total crew	Tons harvested/hr.	Tons harvested/man-hr.
1	Hay loader wagon	Stationary chopper	2½-3	1.2	0.41
2	Hay loader wagon	Hay fork hoist	" "	2.2	.77
3	Hay loader wagons (2)	Hay fork hoist	" "	2.3	.83
4	Hay loader wagons (2)	Hay fork hoist	5-6	4.1	.75
5	Hay loader, crib wag. (2)	Stationary chopper	2	1.5	.79
6	Hay loader, crib wag. (2)	Hay fork hoist	2	1.5	.79
7	Hay loaders(2), crib wag (4)	Hay fork hoist	4	3.1	.79
8	Hay loader, truck	Stationary chopper	1½-2	1.0	.60
9	Hay loader, truck	Hay fork hoist	1½-2	1.4	.85
10	Hay loader, truck	Hay fork hoist	2-2½	1.8	.92
11	Hay loader, trucks (2)	Hay fork hoist	4-5	2.9	.65
12	Buckrake	Stationary chopper	2	1.8	.92
13	Buckrake	Stationary chopper	3	2.2	.70
14	Buckrake	Hay fork hoist	3	2.2	.70
15	Buckrakes (2)	Hay fork hoist	5	4.2	.83
16	Baler, bale loader truck	Bale elevator	3-3½	3.0	.93
17	Baler, bale loader trucks(2)	Bale elevator	5-5½	5.4	.98
18	Baler, hand load trucks	Bale elevator	4-5	2.8	.70
19	Field chopper wagons (2)	Stationary blower	3	2.1	.70
20	Field chopper wagons (3)	Stationary blower	3	2.7	.90

Table 18. Average annual harvesting cost per ton for various combinations of hay harvesting equipment and crews, Connecticut, 1948 (18).

No.	Major equipment used		Man equiv. total crew	Average annual cost per ton if harvesting				Total invest-ment 1/
	Loading	Unloading		25 tons	50 tons	100 tons	200 tons	
1	Hay loader, wagon	Stationary chopper	2½-3	$5.91	$4.41	$3.81	$ -	$ 950
2	Hay loader, wagon	Hay fork, hoist	" "	4.42	3.05	2.42	-	900
3	Hay loader, wagons (2)	Hay fork, hoist	" "	5.19	3.42	2.64	-	1100
4	Hay loader, wagons (2)	Hay fork, hoist	5-6	-	3.81	3.08	2.45	2700
5	Hay loader, crib wagons (2)	Stationary Chopper	2	6.10	3.98	3.15	-	1200
6	Hay loader, crib wagons (2)	Hay fork, hoist	2	5.66	3.67	2.80	-	1100
7	Hay loaders (2) crib wagons (4)	Hay fork, hoist	4	-	5.21	3.63	2.71	3400
8	Hay loader, truck	Stationary chopper	1½-2	4.83	3.47	2.98	-	2500
9	Hay loader, truck	Hay fork, hoist	" "	4.00	2.77	2.23	-	2400
10	Hay loader, truck	Hay fork, hoist	2-2½	3.86	2.63	2.09	-	2400
11	Hay loader, trucks (2)	Hay fork, hoist	4-5	-	3.24	2.68	2.30	4100
12	Buckrake	Stationary chopper	2	5.86	3.68	2.74	-	1100
13	Buckrake	Stationary chopper	3	6.01	3.83	2.89	-	1100
14	Buckrake	Hay fork, hoist	3	5.94	3.76	2.79	-	1100
15	Buckrakes (2)	Hay fork, hoist	5	-	5.13	3.35	2.43	1600
16	Baler, bale loader, truck	Bale elevator	3-3½	-	10.85	6.87	4.67	4800
17	Baler, bale loader, trucks (2)	Bale elevator	5-5½	-	10.94	6.95	4.74	6500
18	Baler, hand load, truck	Bale elevator	4-5	-	10.59	7.01	5.01	4300
19	Field Chopper, wagons (2)	Stationary blower	3	-	11.53	6.37	4.29	5700
20	Field Chopper, wagons (3)	Stationary blower	3	-	10.91	6.40	4.14	5900

1/ Cost if all equipment except one tractor were purchased new at price quotation of Connecticut dealers for February, 1948.

3. Increase output per worker. The man hours per cow can be reduced materially by proper supervision of the labor force, better arrangement of barn and milk house, proper construction of hay racks and correct handling of milk machines (4).

4. Improved breeding practices and methods of selection of replacement cows. Blackstone (4) believes that dairymen who follow this practice reduce the risk of introducing disease into their herds.

5. Blackstone emphasized the use of more effective sanitation and disease control measures. Many cow deaths each year are due to improper supervision.

6. Closer supervision on the part of management in production, buying and selling. Dairymen should give attention to the possibilities of buying at wholesale, buying at times when products can be purchased cheapest, and buying in large quantities (4).

A survey of dairies by Arnold et al. (1) showed that with equally careful management a herd of low producing cows had almost the same overhead costs as did high producing herds. Thus, he continued, the overhead cost per 100 pounds of milk increased as production per cow decreased; likewise, labor required per 100 pounds of milk increased as production per cow decreased when other cost factors remained constant. He reports net cost of milk per 100 pounds sold, also increased as production per cow decreased. Cows producing less than five thousand pounds of milk had total costs 35 percent higher than did those producing 6200 pounds or more (Table 19).

Many workers concur that feed is the largest single item of cost of milk production. Whether or not it pays to use a large amount of purchased

feed depends entirely upon prices of feed and dairy products. Sometimes, milk and feed price ratios are such that they believe it is desirable to depend largely on home grown roughages and pasture, balanced with a minimum of concentrates. This will make the labor cost per 100 pounds of milk somewhat higher. More frequently in the past, price levels have been such that it was profitable to feed more concentrates in the ration for a higher level of milk production per cow and a lower overhead and labor cost per 100 pounds of milk marketed (1).

Table 19. Relation of milk sales per cow to hours of labor and total cost per 100 pounds of milk (1).

Milk sold per cow	Number of farms	Average milk sales per cow	Labor/100 pounds of milk sold	Net cost of milk sold per 100 pounds
Pounds		Pounds	Hours	
Less than 5,000	24	4,421	4.48	$ 3.58
5,000 to 6,199	34	5,580	3.33	3.05
6,200 or more	31	6,991	2.50	2.66
All Farms	89	5,868	3.14	2.96

From a study in New York, during 1944-1945 (1), it was found that high output of milk per worker was an important key to production efficiency and financial success. High output of milk per man was obtained by these practices:

1. Keeping moderately large herds which made possible,
2. Spending less than the average amount of time per cow to do the

dairy chores in the stable and yet,

3. Having better than average producing cows.

Blanch et al. (5) have found in addition to the inputs of feed and labor that certain intangible factors and possible higher costs are encountered when attempting to maintain more even production. These center around the breeding program and replacement practices. Many farmers consider spring as the natural time for cows to freshen. Cows that are difficult to settle do not work into a planned breeding program very well. While they can be replaced in the herd, a higher rate of turnover would tend to result in higher production costs.

Where the dairyman raises his own replacements, Blanch et al. (5) believed it advantageous whenever possible for him to keep calves born in the mid winter months. In this way time is available to care for them when young and they can be turned in the calf pasture with lush feed available at a young age. This minimizes the total labor and feed costs for growing them. Delayed breeding of these winter born heifers involves greater than normal costs in raising the replacements to production.

Arnold et al (1) considering only original or first costs, figures it may be cheaper for many dairymen to purchase replacements than to raise them. There are, however, many disadvantages in purchasing cows.

Many people feel it almost impossible to build up a high producing herd from purchased cows, because their ancestry is largely unknown and selection and breeding of high producing families cannot be practiced. High producing cows cost more per year to keep, but they make more efficient use of their feed and produce milk at a lower cost per 100 pounds (1).

Where replacements are purchased, some opportunity exists to buy cows

bred to freshen at a certain time. As long as quality of cows purchased does not have to be sacrificed, this is a convenient way for those who can or must use it to shift the herd's seasonal pattern of freshening and thereby level out the seasonal pattern of production (5).

While it is physically possible to change an existing seasonal pattern of production with the resulting costs it may not be economically feasible. Blanch et al (5) feel that consideration should be given to costs and returns for different patterns of production before attempting to change. The most profitable seasonal pattern will vary among farmers and the circumstances existing in a given market at a given time. If regulated prices for fluid milk are not adjusted seasonally and if all the production, irrespective of the amount of milk produced during the period of lowest cost per cow, which is the early spring and summer months, the greater the net returns from the milking herd.

There was wide concern that the prevalence of abortion and udder trouble was higher in herds with purchased replacements than in herds raising their own replacements. There was also the possibility of introducing brucellosis, mastitis or other diseases into the herd from purchased cattle (1).

Many workers were in agreement that cows purchased for replacements do not last as long on the average in the service of the purchaser as raised stock. One reason is that purchased cows sometimes have had one or more lactations and some are eliminated soon because of disease, low production or other reasons (1).

Cows in Florida dairies (1) with raised replacements were found to have an average life span of 6.6 years, or about 4.1 years of productive

usefulness in the herd. This is about 37 percent longer service life than was obtained from purchased cows (Table 20).

It is commonly agreed that the longer period of usefulness of raised replacements, even if their first cost is somewhat higher, may make their cost per year of service and per 100 pounds of milk less than with purchased cows. This is because their cost is spread over a longer period of useful life and higher total milk production (1).

Professor W. J. Fraser of Illinois (Arnold et al., 1) said, "It takes all the profit a good cow can make in her first two years to pay off this debt of cost at first calving". "Whether or not she will prove a profitable cow will depend upon how many years she continues after this to return a good profit over the cost of her keep". The length of her producing life has a great deal to do with the profit she earns for the dairyman.

The reasons for replacements of dairy cattle are shown in Table 21. Mastitis and udder trouble were responsible for 21 percent of all disposals. This was the most serious cause of loss reported by Arnold et al. (17). Various diseases, reproductive trouble, accidents and old age were the important reasons for death.

No set rate of depreciation can be assigned to dairy cows that will apply under all conditions (1). Depreciation rates change with changes in the various factors which enter into depreciation costs. These factors are:

1. Initial cost of cow at first calving or at time of purchase.
2. Length of useful life in years.

Table 20. Average useful life span of 978 Florida dairy cows — all breeds (1). (Excludes cows sold for dairy or breeding purposes only)

Attained age	Number of cows still living	Percent of total number	Average age at disposal	Anticipated Usefulness at Different Ages
Years			Years	Years
2.0 to 2.9	978	100.0	6.6	4.1
3.0 to 3.9	918	93.9	6.9	3.4
4.0 to 4.9	798	81.6	7.4	2.9
5.0 to 5.9	673	68.8	8.0	2.5
6.0 to 6.9	509	52.0	8.8	2.3
7.0 to 7.9	393	40.2	9.5	2.0
8.0 to 8.9	292	22.9	10.3	1.8
9.0 to 9.9	196	20.0	11.2	1.7
10.0 to 10.9	128	13.1	12.2	1.7
11.0 to 11.9	91	9.3	12.9	1.4
12.0 to 12.9	59	6.0	13.6	1.1
13.0 to 13.9*	35	3.6	14.6	1.1
14.0 to 14.9*	18	1.8	15.8	1.3
15.0 to 15.9*	14	1.4	16.2	.7
16.0 to 16.9*	7	.7	17.1	.6
17.0 to 17.9*	-	—	—	—
18.0 to 18.9*	2	.2	18.6	.1
19.0 to 19.9*	1	.1	19.2	.0

* Insufficient numbers to be significant.

Table 21. Principal reasons for disposal of 1,469 Florida dairy cows, as given by dairymen (1). (Excludes cows sold for dairy or breeding purposes only)

Reason for disposal		Number of cows	Percent of total
Mastitis and udder trouble		309	21.0
Low production (culled)		216	14.7
Reproductive troubles		137	9.3
Old age		29	2.0
Combination of above reasons		66	4.5
Accidents and injuries		33	2.3
Diseases		50	3.4
Other reasons		30	2.0
Unstated		417	28.4
Death:			
Diseases	84		
Reproductive troubles	30		
Accidental death	21		
Old age	12		
Unknown causes	35		
		182	12.4
Total		1,469	100.0

3. Salvage value, which fluctuates with beef prices.

4. Death rate.

When the initial cost, service life, salvage value and death rate of dairy cows are known, the depreciation rate may be calculated by the following formula:

$$\frac{\text{Cost}}{\text{No. years of use}} - \frac{1}{\text{No. years of use}} - \frac{\text{Deaths per 100}}{100} \times \text{Salvage value}$$

= Depreciation cost per year in dollars (1).

A longer useful life is important in keeping down annual depreciation cost per cow (1). They believe by adding a year to a cow's service life spreads the cost of her unproductive years over a longer period.

In the study (Arnold et al., 1) the higher the initial cost of a cow, the higher her annual depreciation, assuming a fixed life span and salvage value. Further, they believe depreciation cost per year increases more than proportionately with increasing cost. This, however, does not point toward the use of low grade cows, as their productivity may also be low and other costs higher.

At any given life span and initial cost of a cow, as reported by Arnold et al. (1), depreciation cost per gallon decreases directly as production per year increases. The dairyman should strive for cows of higher production and make every effort to extend their profitable service life to obtain the lowest depreciation cost per gallon of milk produced (Table 22).

Production of Grade A milk has increased to a level that considerable surplus has existed during the flush production period (Blanch et al., 5).

Table 22. Effect of useful life and initial cost of a cow on depreciation cost per gallon of milk at varying rates of productivity (1).

Useful life years	Assumed Valuation	Depreciation cost per year	Depreciation 600 gallons	Cost 800 gallons	Per gallon 1000 gallons
			Effect of Useful Life		
1.0	$150	$73.12	$0.122	$0.091	$0.073
2.0	150	38.12	.064	.048	.038
3.0	150	26.46	.044	.033	.026
4.0	150	20.62	.034	.026	.021
5.0	150	17.12	.029	.021	.017
			Effect of Initial Cost		
3.0	100	9.79	.016	.012	.010
3.0	150	26.46	.044	.033	.026
3.0	200	43.13	.072	.054	.043
3.0	250	57.79	.096	.072	.058
3.0	300	76.46	.127	.096	.076

Because of the seasonality of flow, little more than enough milk to meet the demands of the market has existed during the fall and early winter months. With an abnormally wide spread between the regulated price of Grade A milk for fluid consumption and the price surplus milk has brought in the open market for manufacturing purposes, producers with abnormally high spring and early summer production patterns have obtained average prices considerably lower than those who have essentially stayed within their quotas. It is questionable whether the annual average production costs of these producers were sufficiently lower to compensate for this lower average price.

Blanch et al. (5) affirms that for the future, the answer to the most profitable pattern of production for an individual farmer lies in the manner in which production quota is allocated and in the relationship between the minimum price established for milk sold in the bottle and can trade and with the market price of manufacturing milk. It does not appear that differences in production costs alone are of such magnitude as to be a heavy determinant in directing a production pattern.

Most of the seasonal variation in production costs can be attributed to two factors:

1. Differences in feeding practices and feed costs.

2. Differences in milk production by months which is primarily a result of herd management (5).

Another factor listed by Blanch et al. (5) that affects the most profitable pattern of production for individual farmers is the type of pastures utilized. It is conceivable that production costs should be lowered sufficiently by the use of economical pastures with high grazing

capacity, that an individual producer might well be able, under normal conditions, to take a slightly lower price for his surplus during the period of seasonally high production and obtain higher net return for the year as a whole than if he merely attempted to meet his quota each month of the year. The price spread between bottle and manufacturing milk normally is too great to make this likely for any extended period.

For the year of the study an average of 7422 pounds of milk testing 4.3 percent butterfat was produced per cow. This milk was valued at $402.82 per cow, or $5.43 per 100 pounds. The net average cost of production was $438.06 per cow, or $5.90 per 100 pounds of milk (Table 23). This loss amounted to $36.24 per cow, or 47¢ per 100 pounds of milk (5).

Table 23. Variation in annual labor input per cow, 61 grade A dairy farms, Willamette Valley section, Portland Milkshed, Year ending September 30, 1947 (5).

Range in labor input	Number of farms	Percent of farms	Percent of cows
Less than 100 hours	6	10	12
100 - 129 hours	14	23	30
130 - 159 hours	17	28	31
160 - 189 hours	10	16	15
190 - 219 hours	5	8	4
220 hours and over	9	15	8
Total	61	100	100

Blanch et al. (5) reported that not all farmers suffered a loss. Primarily because of lower than average production costs, nearly two-fifths, 38 percent, of the dairymen showed a net profit. This profit averaged 51¢ per 100 pounds of milk and ranged from a high of $1.94 to a low of 1¢. While the number of producers enjoying a profit amounted to only 38 percent, they produced 58 percent of the milk. Thus, over half of the milk was produced at a profit, reflecting the fact that the lower cost of producers were larger than average.

Milk produced in November cost 1.8 times as much as milk produced in May. The seasonal variation in the cost of producing butterfat was slightly less than milk (5).

Much of the seasonal variation in milk production cost reported during the different months of the year appears to be associated with differences in kinds and costs of feed fed and in the differences in amounts of milk produced. Generally, the months when the cost per cow was the lowest was when the milk produced per cow was highest. Differences in milk production is a herd management problem (5).

Seasonally, the price received for milk was high enough to cover production costs only during the months of April, May, June and July (Fig. 3). These were the months during which milk flow was highest and unit production costs were lowest (5).

Nearly two-thirds of the total labor charged to the milking herd was the labor and management of the operator's family; 25 percent was hired, and the remainder was supplied by members of the operator's family who did not receive a regular wage. Considerable variation existed in the amount of labor that was necessary to care for a cow

61 Dairy Farms, Willamette Valley Section, Portland Milkshed,
Year Ending September 30, 1947

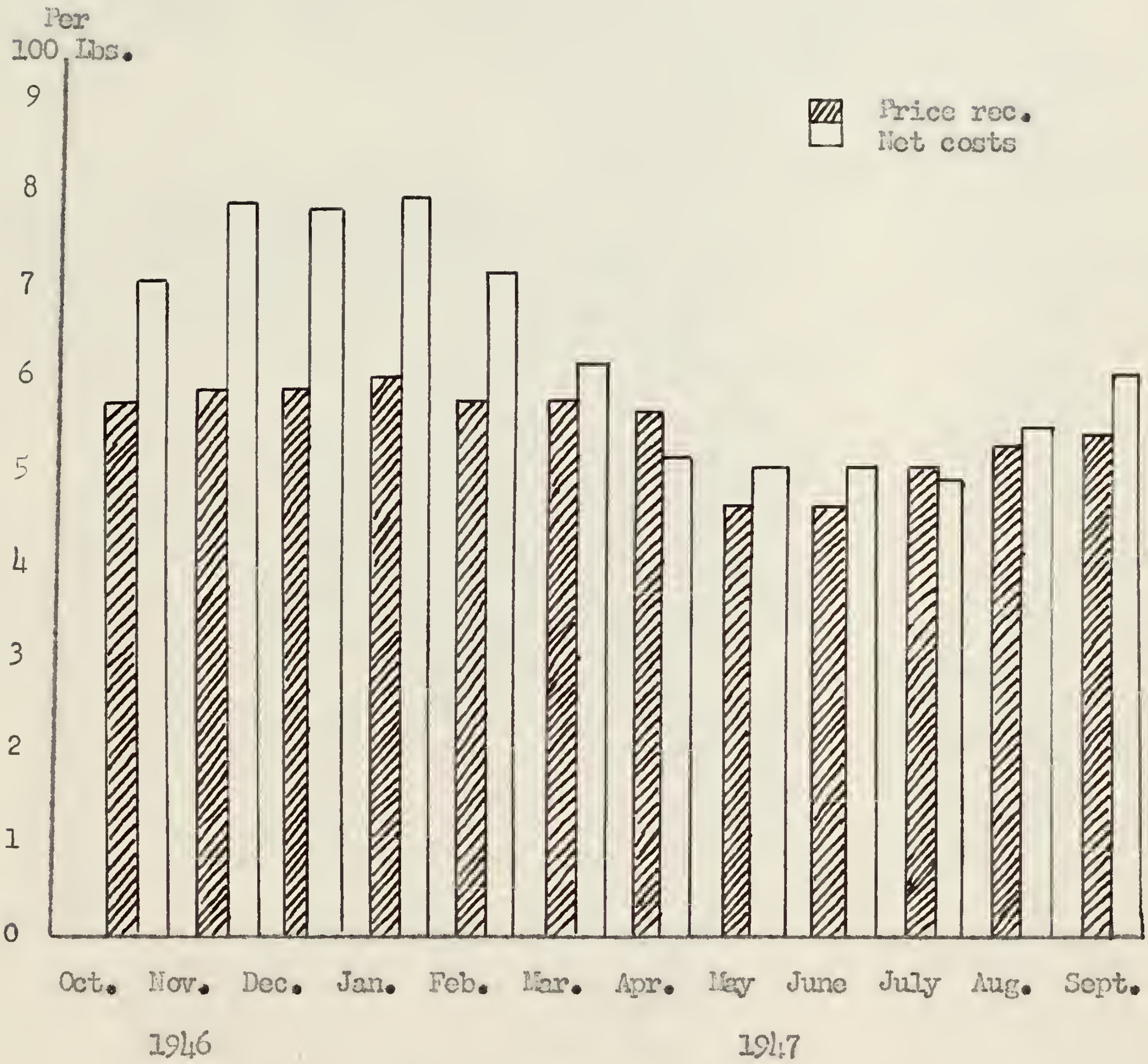


Fig. 3. Seasonal variation in prices received for milk sold and production costs.

for a year (Table 24). Over 60 percent of the farms used between 100 and 160 hours per cow, 10 percent used less than 100 and the others used 160 hours or more. A close association existed between size of herd and labor per cow (5).

Table 24. Variation in annual labor input per cow, 61 grade A dairy farms, Willamette Valley Section, Portland Milkshed, Year ending September 30, 1947 (5).

Range in labor input	Number of farms	Percent of farms	Percent of cows
Less than 100 hours	6	10	12
100 - 129 hours	14	23	30
130 - 159 hours	17	28	31
160 - 189 hours	10	16	15
190 - 219 hours	5	8	4
220 hours and over	9	15	8
Total	61	100	100

The average value of investment per cow was $479.00. This amounted to about $11,700 per farm. This included only the milking herd's proportionate share of the value of the buildings, corrals, equipment and other items used in the production of milk. The value of the milking herd was included, but the value of the farm land on which feed was grown for the cows was not. At the rate of 4.0 percent, the investment charge, other than depreciation and repairs, was only $19.16 (Table 25) (5).

Table 25. Average capital investment chargeable to the milking herd, 61 Grade A dairy farms, Willamette Valley section, Portland Milkshed, year ending September 30, 1947 (5).

Item	Investment per farm	Investment per cow	Total investment percent
Buildings	$ 5,498	$ 225	47
Cows	4,823	198	42
Land	731	30	6
Equipment	622	26	5
Total	$11,674	$ 479	100

Blanch et al. (5) further reported that production per cow had a marked influence on the net cost of producing milk. As the butterfat per cow increased from a herd average of 257 pounds to 420 pounds, the cost of producing one pound of butterfat decreased 27¢ from $1.48 to $1.21. The cost of producing 100 pounds of 4 percent fat corrected milk declined 99¢ from $6.06 to $5.07. Only those herds producing 380 pounds or more of butterfat showed a net profit above all costs.

The herd in the study on which labor was used most efficiently produced butterfat for $1.21 per pound as compared to $1.77 for those on which labor was used most inefficiently. A cost spread of $2.43 per 100 pounds of 4 percent FCM existed between the most and least efficient dairies. High labor efficiency is much more easily attained with moderate to large herds (5).

The cost of producing milk and butterfat decreased consistently as

the number of cows increased from a herd average of 10 to 55. The spread was 45¢ per pound of butterfat and $2.10 per 100 pounds of milk. Between a herd average of 10 and 19 cows, the addition of each cow reduced the cost of producing milk by efficient use of labor, buildings and equipment. No pattern of relationship existed between size of herd and production per cow (5).

The herd with the most even pattern of production produced 93 percent as much milk in the low quarter as it did during the quarter of highest milk production. The herds with the most uneven pattern of production produced butterfat and milk at the lowest cost. Very little difference in cost existed between the medium and most even producing herds (5).

The difference in cost between the even and uneven flow herds was due to the fact that the uneven flow herds used relatively more pasture, less labor, less hay and concentrates than the other herds and were slightly larger in size (5).

The level of concentrate feeding should be determined by:

1. The individual cow's ability to utilize the concentrates in the production of milk.

2. The cost of the concentrates.

3. The value of the milk used.

If concentrate prices are low in relation to milk prices, concentrates can be profitably fed at a higher rate than when they are high in price in relation to milk (5).

SUPPLY AND PRICE AT VARIOUS FLUID MILK MARKETS

Milk is an important food (Pritchard, 39). It is consumed principally in fluid form. In this form it is generally regarded as a necessity of life without close substitutes. In smaller volumes it is used as a complementary food and in cooking.

Pritchard (39) related factors affecting consumption of fluid milk and cream. Economic theory and observation of consumer uses of these products indicate that the most important are:

1. Retail price of fluid milk and cream.
2. Retail price of all other commodities (cost of living index).
3. Disposable income per-capita.
4. Consumption habits developed in the past.
5. Nutritional education.
6. Retail price of evaporated milk and other factors may affect consumption (39).

The prices paid for milk at the farm according to Bowring (8) are prices at the receiving station or manufacturing plant less the cost of transportation from the farm. He further stated that the price at the receiving station is the final market price less the cost of transportation to market and all handling and processing charges. The closer the assembly plant and the farm are to market, the higher the price should be at the farm. If prices were free and competitive, then a producer would ship to the market which affords the highest price at the farm. Likewise, milk assembly plants would tend to be located close to the retail market.

Pritchard (39) stated responses of farmers to prices and other variables are of two types, production responses and disposal responses. Production responses affect the quantity of milk produced in a supply area. Disposal responses affect the quantities of milk sold in different markets.

Farmers can be expected to sell milk where the price is highest, with reasonable allowance for price and cost differences due to quality, distance from markets and possible other factors. A rise in price relative to producer prices in competing markets can be expected to cause some producers to enter the market. A relative fall in milk prices usually will have the opposite effect (39).

Bowring (8) stated that if a choice between two markets is to be made, then the market price less charges will be the measure of preference. Milk will be shipped to the market offering the highest farm price.

An increase in the price at one market relative to the other will broaden the area from which one market will collect milk supplies. Supplies on the lower priced market will be decreased an equal amount. It becomes obvious that if milk producers are price responsive, the relative prices between markets direct the supplies of milk. The problem then resolves into balancing demand and supply for each of the markets and to find those prices which will best stabilize this relationship (8).

The supplies can be so allocated between markets by pricing techniques that mileage of hauls and handling charges are reduced to a minimum. Secondary markets will then be in a position to price their

milk at retail with greater consideration for the location of supplies, and consumers as well as producers will benefit from proximity to each other (8).

Pritchard (39) believes these production and disposal responses are not likely to be as great as the changes in relative prices or costs. The responses are limited by other economic and physical factors. In the short run, limited changes in production per cow can be made by varying feeding rates. Small increases and large decreases in cow numbers are possible in the short run. Large increases require more time.

In addition, a large change in cow numbers would require important changes in farm organization on most farms. These may be costly to make. Unstable prices and other uncertainties tend to reduce responses to economic factors. Farmers generally have found it wise to plan for less than maximum incomes in order to hedge against unforseeable misfortunes (39).

It appears that changes in farm milk prices relative to other economic factors have small effect on milk production.

An increase in fall and winter production without an increase in spring and summer is needed to fit supplies to market requirements and to permit more effective use of supplies by milk distributors (39). The causes of seasonal fluctuations in milk production are both physical and economic (52). The principal cause of these seasonal variations is differences in feed costs. Managerial requirements are greater to maintain a dairy herd on a fall or even freshening schedule than on a spring freshening pattern (39, 52).

Pritchard (39) believes several factors partially offset the higher costs of fall-winter and seasonally even production. Fall-winter milk prices are generally higher than spring and summer prices. As a result of this the gross annual income of fall producers exceeds annual gross returns of spring and summer producers. Second, cows freshening in the fall receive a second production stimulus from spring pastures. Spring freshening cows usually produce a larger total volume of milk. This tends to reduce average milk production costs. Fall-winter dairying permits a better seasonal distribution of total farm labor requirements than does spring-summer dairying. This is because the peak labor load of the dairy enterprise comes in the fall and winter when other farm work is lightest.

Williams (52) reported buttermilk and chocolate drink offer a potential market for additional quantities of fresh skim or low fat milk of bottling quality. Another possible market for more fluid milk is in frozen dairy products. Under present conditions, it is unlikely that the price paid for milk used in any of these products will be as high as that paid for milk used in bottled whole milk and cream.

With expanded supplies of fluid milk the market for high butterfat might become saturated. Dairymen selling high testing milk might then find themselves producing extra butterfat at comparatively high costs (52).

Fluid milk prices in major cities usually are negotiated by organised producers and dealers, with or without government supervision. That is, fluid milk prices are administered prices. Two factors appear to be primarily responsible for this (39).

Milk is a bulky, perishable product. Its production and processing are subject to urban health regulations. As a result milk tends to be produced in areas adjacent to the cities in which it is consumed (39).

Economies of size in fluid milk distribution appear to be large. The trend has been toward fewer and larger distributors. Bargaining associations to represent producers and distributors were formed (39).

Price formulas have become common in major markets as a means of simplifying and improving the efficiency of price administration. Formula pricing is flexible and automatic. It reduces the number of price negotiations and costs of bargaining (39).

Possible objectives reported by Pritchard (39) of administering prices to consumers is to increase consumption, increase producers' returns and dealers' profits, assuming that these are too low. Other aims are to improve the market and reduce uncertainty and instability of milk prices by establishing prices of fluid milk at competitive levels.

Competition within the dairy industry and between it and the rest of our economy have in general, kept milk prices in line with the general level of all commodity prices and of all farm prices (39).

A study was made by Williams (48) on the overall efficiency of milk processing and distribution. Not quite two-thirds of distributor's receipts were spent for milk and other materials used in products sold. More than nine-tenths of this expense was for fluid milk.

About a third of distribution receipts went to meet operating expenses, which did not include any charge for interest, income taxes, or compensations for risk. Nearly half of these expenses were for plant

labor costs, container expense and building and plant equipment cost (48).

In 1948 operating expenses averaged 5.6¢ per quart of whole milk. After meeting operating expenses, distributors had left for use of capital and risk, returns varying from 1.3¢ to minus 1.5¢ per quart equivalent (48).

Williams (48) stated that volume per plant influences productive cost. In general, plant delivery and administrative labor was used more effectively in larger plants than in small ones. These efficiencies were not reflected in lower costs because of the high wages paid by large distributors. But gross margins were wider in large plants than in small ones, consequently, large distributors made much better incomes than did small distributors.

Adequate volume of business is most important for efficient plant operation and wholesale distribution (48).

A review of the literature relative to dairy cattle management suggests the following comments:

1. Size of business, whether measured by the number of cows kept or by productive man-work units, has considerable effect on earnings. Large farms are the most profitable.

2. Efficient production is as important as high production in securing highest farm income.

3. All necessary roughage should be produced on the farm, as cost of production is higher when roughages are purchased.

4. Capital efficiency may mean the difference between profit and loss. Cost of production decreases as the amount of milk per cow increases.

5. All factors of production must be utilized to their full capacity if the farm operator is to maximize his earnings.

6. Efficient use of labor is important in reducing costs.

7. Dairymen should utilize the maximum amount of good pasture and grass silage in the dairy ration, feeding enough grain to make the ration adequate. The more high quality roughage consumed, the less expensive grain needed. Better nutrition means longer productive life.

8. The principal cost of milk production is feed. Reduction in the cost of production can best be achieved by improving feeding practices and increasing the output per worker.

Adequate volume of business and good management practices are the most important considerations for efficient operation and maximum income.

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REVIEW OF RESEARCH PERTAINING
TO DAIRY CATTLE MANAGEMENT

by

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Farmers' income is affected by the general price level and the way they manage their farms.

King considers the basic starting point for developing a long range dairy program as the land and the kind and quantity of crops grown. He believes it important to produce high quality hay, silage and pasture.

Feed is the principal cost of milk production. Other big costs are for labor, cows and equipment. Distribution costs and retail price need to be reduced to promote increased milk consumption.

A considerable amount of capital is required to own and operate a successful farm. The national average for 1950 was about $3000 invested in real estate for every $1000 returned from farm products sold. Real estate investments increase as farm income increases, but not in direct proportion. Less investment in real estate is required to produce $1000 in gross sales on farms with a high level of income than on low income farms. Size of farm increases more rapidly than value per acre as farm income increases.

Use of marginal land is at an increasing disadvantage as agriculture becomes more mechanized and interregional competition for markets develops. In the better land classes there are fewer but larger farms, carrying more animal units per farm and growing more crops per animal unit than formerly. If this trend continues the social and economic forces will bring about the complete abandonment of land unsuited to agriculture.

Profitable farming is associated with certain factors which affect net income. A good measure of size on dairy farms is the number of

milking cows kept. A better measure of size is the number of man-work units required to do a given job. Regardless of the way size of business is measured, large farms are the most profitable. Low incomes are most often the result of small size, low production rates, the inefficient use of labor or capital, or a combination of these factors.

Most dairymen have a large task ahead in reorganizing their farms and in learning new skills and adapting improved methods. Any shift to increase the volume of milk produced, would probably require barn remodeling, greater roughage production and addition of more animal units. By expanding in two stages, the extra cows would add income quickly and carry the cost of improvements. The remaining units could be added at regular intervals.

The task of milking largely determines the pattern for the size of the individual dairy enterprise. Operators have tended to keep as many cows as they could milk conveniently. It takes 50 percent of chore time in winter and 80 percent in summer for milking. Most healthy cows can be milked by machine in three and a half minutes. The benefits from greater efficiency in chore work are more leisure, larger output per man or less hired labor. As the quantity of milk produced per man increases, cost per hundredweight decreases. As the milk production per cow increases the cost of production decreases.

To maintain dairying on a profitable basis, cost of production must be kept as low as possible. Roughage, such as pasture, silage and hay, is a cheaper source of nutrients than grain. The dairy cow is a great roughage consumer and can and will consume up to 75 percent of her

required nutrients in the form of roughage. Sufficient pasture should be provided for a cow to consume about 4.5 pounds of grass for each pound of milk produced.

Dairying is the dominant livestock industry in most of the Northeast. The development of the dairy industry has been due to the adaptation of the area to the production of grasses and legumes.

Harvesting the hay crop is hard, tedious expensive work. The weather is either too hot or too wet. Because of this, many farmers are searching for better methods of performing the essential haying jobs. Two types of adjustments may be made to minimize the effects of weather in forage harvesting, grass silage or barn finished hay.

The time cost of each hay harvesting job is related to the equipment used. The decision of an individual farmer to purchase a new hay tool should be dependent upon the saving which can be expected through its operation.

Mow finishing is a process wherein hay, partially dried in the field usually to below 45 percent moisture, is put into a specially constructed hay mow for further drying. However, a mow finisher should not be purchased and installed simply because it is new and great claims have been made for its performance. All other alternatives should be checked before deciding whether or not some other capital investment would be more profitable.

Several harvesting methods and combinations of equipment are being used. The equipment combination should have adequate capacities to harvest the forage produced at various times without excessive loss of

quality from over maturing of some of the crops. The forage harvesting equipment should be tailored to the size of the enterprise to avoid excessive overhead expenses.

The opportunity to have harvesting work done on a custom bases, or to increase the volume of work done by equipment by doing custom work for other operators, should be studied before a decision is made on a particular equipment combination. The balancing of costs and return will indicate if the particular equipment or combination of equipment is profitable.

Blackstone considers it advantageous for dairy farmers to analyze and know their production costs. Since profit represents the difference between selling price and the cost of production, farmers should make intensive efforts to reduce production costs per unit of product whenever possible.

Feed is the largest single item of cost of milk production. If concentrate prices are low in relation to milk prices, concentrates can profitably be fed at a higher rate than when they are high in price in relation to milk.

The prices paid for milk at the farm are prices at the receiving station or manufacturing plant less the cost of transportation from the farm. The closer the assembly plant and the farm are to market, the higher the price should be at the farm.

Farmers can be expected to sell milk where the price is highest. If a choice between two markets is to be made, then the market price less charges will be the measure of preference. Milk will be shipped to the

market offering the highest farm price.

Adequate volume of business and good management practices are the most important considerations for efficient operation and maximum income.